

WHAT IS CLAIMED IS:

1. A photonic crystal fiber preform comprising:

a rod-shaped substrate with a plurality of holes longitudinally formed therethrough
in a photonic lattice structure; and

5 a plurality of longitudinal material members having at least two different indices of
refraction, the members being disposed in the holes,

wherein distribution of index of refraction of the photonic crystal fiber preform is
controlled by arrangement of the members.

2. The preform as set forth in claim 1, wherein each of the members is formed in
10 the shape of a rod, the rod being inserted in the corresponding hole.

3. The preform as set forth in claim 1, wherein each of the holes and members is
formed in the shape of a cylinder, the member being inserted in the corresponding hole.

4. The preform as set forth in claim 1, wherein the index of refraction of the
members monotonically decreases from the center of the preform to the outer
15 circumference of the preform.

5. The preform as set forth in claim 1, wherein the index of refraction of the members monotonically increases from the center of the preform to the outer circumference of the preform.

6. The preform as set forth in claim 1, wherein the index of refraction of the
5 members monotonically either decreases and then increases or increases and then decreases from the center of the preform to the outer circumference of the preform.

7. The preform as set forth in claim 1, wherein the substrate is made of a material containing pure silica.

8. The preform as set forth in claim 1, wherein the substrate is made of a material
10 containing silica and a dopant having a predetermined index of refraction.

9. The preform as set forth in claim 7, wherein the relative index of refraction of each of the members to pure silica is a predetermined percentage.

10. A photonic crystal fiber preform comprising:

a cylindrical substrate; and

a plurality of longitudinal material members having at least two different indices of refraction, the members being disposed in the cylindrical substrate in a photonic lattice
5 structure,

wherein distribution of index of refraction of the photonic crystal fiber preform is controlled by arrangement of the members.

11. The preform as set forth in claim 10, wherein each of the members is formed in the shape of a rod.

10 12. The preform as set forth in claim 10, wherein each of the members is formed in the shape of a cylinder having a diameter smaller than that of the cylindrical substrate.

13. The preform as set forth in claim 10, wherein the index of refraction of the members monotonically decreases from the center of the preform to the outer circumference of the preform.

15 14. The preform as set forth in claim 10, wherein the index of refraction of the members monotonically increases from the center of the preform to the outer circumference of the preform.

15. The preform as set forth in claim 10, wherein the index of refraction of the members monotonically either decreases and then increases or increases and then decreases from the center of the preform to the outer circumference of the preform.

16. A photonic crystal fiber preform comprising:

5 an outer cylindrical substrate with a plurality of first holes longitudinally formed therethrough;

an inner rod-shaped substrate fitted in the outer cylindrical substrate, the inner rod-shaped substrate having a plurality of second holes longitudinally formed therethrough, the first and second holes being arranged in a photonic lattice structure; and

10 a plurality of longitudinal material members having at least two different indices of refraction, the members being disposed in the first and second holes,

wherein distribution of index of refraction of the photonic crystal fiber preform is controlled by arrangement of the members.

17. The preform as set forth in claim 16, wherein each of the members is formed in
15 the shape of a rod.

18. The preform as set forth in claim 16, wherein each of the members is formed in the shape of a rod, the rod being inserted in the corresponding hole.

19. The preform as set forth in claim 16, wherein each of said substrates has a respective diameter, and wherein each of the members is formed in the shape of a cylinder having a diameter smaller than that of the inner substrate if located within the inner substrate, and otherwise having a diameter smaller than the outer substrate diameter minus
5 the inner substrate diameter.

20. A photonic crystal fiber comprising:

a rod-shaped substrate with a plurality of holes longitudinally formed therethrough in a photonic lattice structure; and

a plurality of longitudinal material members having at least two different indices of
10 refraction, the members filling in the holes,

wherein distribution of index of refraction of the photonic crystal fiber is determined by arrangement of the members.

21. The fiber as set forth in claim 20, wherein each of the members is formed in the shape of a rod.

15 22. The fiber as set forth in claim 20, wherein each of the members is formed in the shape of a cylinder.

23. The fiber as set forth in claim 20, wherein the index of refraction of the material layers monotonically decreases from the center of the fiber to the outer circumference of the fiber.

24. The fiber as set forth in claim 20, wherein the index of refraction of the
5 members monotonically increases from the center of the fiber to the outer circumference of the fiber.

25. The fiber as set forth in claim 20, wherein the index of refraction of the members monotonically either decreases and then increases or increases and then decreases from the center of the fiber to the outer circumference of the fiber.

10 26. The fiber as set forth in claim 20, wherein the substrate is made of a material containing pure silica.

27. The fiber as set forth in claim 20, wherein the substrate is made of a material containing silica and a dopant having a predetermined index of refraction.

28. The fiber as set forth in claim 26, wherein the relative index of refraction of
15 each of the members to pure silica is a predetermined percentage.

29. A photonic crystal fiber comprising:

a cylindrical substrate; and

a plurality of longitudinal material members having at least two different indices of refraction, the material layers being disposed in the cylindrical substrate in a photonic
5 lattice structure,

wherein distribution of index of refraction of the photonic crystal fiber is determined by arrangement of the members.

30. The fiber as set forth in claim 29, wherein each of the members is formed in the shape of a rod.

10 31. The fiber as set forth in claim 29, wherein each of the members is formed in the shape of a cylinder having a diameter smaller than that of the cylindrical substrate.

32. The fiber as set forth in claim 29, wherein the index of refraction of the members monotonically decreases from the center of the fiber to the outer circumference of the fiber.

15 33. The fiber as set forth in claim 29, wherein the index of refraction of the members monotonically increases from the center of the fiber to the outer circumference of the fiber.

34. The fiber as set forth in claim 29, wherein the index of refraction of the members monotonically either decreases and then increases or increases and then decreases from the center of the fiber to the outer circumference of the fiber.

5 35. A photonic crystal fiber comprising:

an outer cylindrical substrate with a plurality of first holes longitudinally formed therethrough;

an inner rod-shaped substrate fitted in the outer cylindrical substrate, the inner rod-shaped substrate having a plurality of second holes longitudinally formed therethrough, the

10 first and second holes being arranged in a photonic lattice structure; and

a plurality of longitudinal material members having at least two different indices of refraction, the members being disposed in the first and second holes

wherein distribution of index of refraction of the photonic crystal fiber is determined by arrangement of the members.

15 36. The fiber as set forth in claim 35, wherein each of the members is formed in the shape of a rod.

37. The fiber as set forth in claim 35, wherein each of the substrates has a respective diameter, and wherein each of the members is formed in the shape of a cylinder having a diameter smaller than that of the inner substrate if within the inner substrate, and

otherwise smaller than the outer substrate diameter minus the inner substrate diameter.